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FERTILIZER PLACEMENT FOR POTATOES

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For several years cooperative investigations have been conducted to determine what constitutes the best method of applying fertilizer for potatoes. Studies have been conducted under field conditions on important potato soil types in Maine, Michigan, New Jersey, New York (L. I.), Ohio and Virginia in which a number of methods of fertilizer placement have been compared. The chief comparisons have been as follows: (a) Fertilizer applied in bands on each side of and level with seed piece at distances of 1, 2 and 4 inches; (b) applied in bands on each side and 2 inches below seed piece level; (c) applied over seed piece; (d) applied in band underneath seed piece, with 1 to 2 inches of fertilizer-free soil interposed; (e) in furrow, lightly mixed with soil, and (f) in furrow, well mixed with soil. Annual statements covering the work have appeared in this Journal and in the Proceedings of the Joint Committee on Fertilizer Application.

As the experimental studies now represent twenty-seven individual field experiments it will be of some interest to ascertain whether a consistent trend is shown in favor of any of the fertilizer placement methods. Several ways of handling the results have been undertaken, on the basis of actual potato yields.

First.—By placing the results of the 27 tests on the basis of highest and lowest yield with respect to method of placement it is found that of this number, 23 gave highest yields where the fertilizer was

[1]Conducted by the Maine, Michigan, New Jersey, New York and Ohio Agricultural Experiment Stations, the Virginia Truck Experiment Station and the Bureaus of Agricultural Engineering and Plant Industry, U. S. D. A., in connection with the Joint Committee on Fertilizer Application.

placed in bands on each side of the seed piece. In Maine, for example, side placement has given highest yields each season over a four-year period. In Michigan, from 13 tests, 12 have given highest yields with side placement of fertilizer. In Ohio, side placement has proved superior each year over a four-year period. In Virginia, for a four-year period, side placement was superior for three years of the four. On Long Island, for two years only, fertilizer lightly mixed in the row proved to be the main exception to the trend. The results have generally followed in other potato producing sections. In New Jersey side placement proved best over a five-year period.

Second.—Another method of presenting the results for the entire experimental period is shown in the accompanying table by rating the placement methods according to the number of times giving highest and lowest yields. A consideration of table 1 shows a marked superiority for side placement as compared with other methods of fertilizer

TABLE 1.—*Frequency of fertilizer placement methods with respect to highest and lowest yield*

Placement Number	Location of Fertilizer	Number of Times Producing	
		Highest Yield	Lowest Yield
1	Side bands, 1" from seed piece, same plane	5	0
2	Side bands, 2" from seed piece, same plane	9	0
3	Side bands, 4" from seed piece, same plane	5	1
4	Side bands, 2" from and 2" below seed piece level	4	2
		23	3
5	Row, lightly mixed with the soil[1]	2	3
6	Row, well mixed with the soil[2]	1	11
7	Band underneath seed piece.	1	7
8	Over seed piece	0	3
		4	24

[1]Fertilizer was confined largely to the soil zone immediately above the seed pieces.

[2]Fertilizer distributed throughout the soil zone surrounding the seed pieces.

placement. Of the different side placements, No. 2, fertilizer applied in bands 2 inches on each side of seed piece and on a level with the lower plane of the seed piece, was superior. Considering lowest yields, No. 6 method, fertilizer well mixed in furrow, was decidedly the poorest, being lowest in 11 of the 27 cases. With respect to the method in which the fertilizer was applied over the seed piece this gave lowest yields in all tests conducted.

Third.—Still another method of presentation is shown in table 2, the results being given in terms of actual acre yields, in bushels, for each section during the full period covered by the experimental work. Three representative placement methods which were used throughout the experimental period are used to show the yield differences obtained. In every case the advantage is distinctly in favor of side placement, indicated by the increases given in parenthesis.

TABLE 2.—*Potato yields from representative fertilizer placements Expressed on average basis for period*

Location	Period	Placement of Fertilizer		
		1—Side	2—Band under	3—Mixed in Row
		Bus.	Bus.	Bus.
Maine	4 years	392	357 (35)	349 (43)
Michigan	5 years	203	188 (15)	177 (26)
New Jersey	5 years	274	230 (44)	250 (24)
Ohio	4 years	238	226 (12)	225 (13)
Virginia	4 years	248	215 (33)	228 (20)

1. Side placement, in bands, 2 inches from, and slightly below level of, seed-piece.
2. In band, 4-5 inches wide, underneath seed-piece with approximately one inch of soil between fertilizer and seed-piece.
3. In row, well mixed with soil, throughout a cross sectional area about 5 inches wide and 2 inches deep, with the seed-piece located at the center.

The cooperative study of representative fertilizer placements conducted in several states since 1931 has consistently indicated the side placement to be the best for potatoes in a number of important potato-producing sections. It is the feeling of those most concerned with

the experimental studies that the placement of fertilizer in a narrow band at each side of the row about 2 inches away, and on a level with, or slightly below, the seed piece should now be accepted as a recommended practice. Potato planters with suitable fertilizer placement equipment are available and a great many potato growers have adopted the side placement method of fertilizer application.

POTATO VARIETY NOMENCLATURE

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In a letter written on February 6, 1936, by Secretary Martin, the writer was requested to serve as Chairman of the Potato Association of America Nomenclature Committee for the current year, the acceptance of which was later followed by the appointment of C. F. Clark, Bureau of Plant Industry, Washington, D. C., C. H. Metzger, Experiment Station, Fort Collins, Colorado, Julian C. Miller, College of Agriculture, Baton Rouge, Louisiana, and L. C. Young, Dominion Experiment Station, Fredericton, N. B. The following letter was sent to each member: "As Chairman of your Committee, I would like to get the opinion of each member as to what we may profitably undertake this season and to that end, as a suggestion, I am submitting the following questions:

1. "Are there any nomenclature problems in your section? If so, what are they?
2. "Do you think it would be advisable for each member of the committee to study all varieties of questionable nomenclature with a view to their proper identity?
3. "In your opinion, would it be advisable to request all originators of new varieties to submit a sample to the committee for study prior to their introduction?"

Believing that the replies to this communication by the committee members should be of interest to the members of the Association, they are hereby presented. Dr. Clark replied as follows:

1. "With reference to the State of Maine there are some nomenclature problems of importance. For example, there are a few growers in the State who persist in attempting to certify stock, which very closely resembles Green Mountain, under other names,

particularly Delaware and Gold Coin. If it can be shown that these stocks are identical with Green Mountain the names should be eliminated, as they only add confusion to the work of seed certification.

2. "During the past several months I have been attempting to get together a collection of all the potato varieties grown in this country so that a study of means of identification may be made. It is probable that a large part of these are so well established that no study of them will be necessary by other members of the committee. However, in the case of disputed names, I think it would be advisable for the findings of one member of the committee to be confirmed by the others. My opinion is that this would include only a relatively small number of varieties. (In a later letter Dr. Clark advises that he has eighty-eight different lots in his variety collection.)

3. "I would be in favor of requesting the originators of new varieties to submit a sample to the committee for study prior to their introduction. This might serve a useful purpose in detecting or preventing the giving of new names to old varieties."

The following comments were received from C. H. Metzger:

1. "I would say we do have nomenclature problems in our section. First we have three distinct types of Peachblow potato; one is white with a pink eye; the second is pink with a dark red eye, and the third has a dark red skin. All three of these varieties are known by the same name and it leads to considerable confusion. I believe these three types are distinct enough to warrant separate names. We also have another problem in regard to the Russet Burbank and the Netted Gem. We have been growing this type of potato at the Station for the last ten years and simply, from observation, believe that there are possibly two distinct varieties. Next we have five distinct types of Triumph, based on height of vine, tuber color, tuber shape, time of maturity and number of blossoms. These should be designated in some special way. Then there is also the question of synonyms and mis-named varieties.

2. "I also believe that the committee should straighten out these matters, and study the varieties of questionable nomenclature with the view to their proper identity.

3. "I also believe that the Committee should study all new varieties prior to their introduction but merely, however, from a nomenclature and classification standpoint."

J. C. Miller offered the following comments:

1. "Just at present there are no nomenclature problems in my section of the country; however, as soon as my breeding project advances to the point where I would like to have some of my more promising seedlings released, there would then be a distinct problem.

2. "If the potato is suitable, I think it might be well to try any new or questionable potato in the various regions of the country where the members of the committee are located. In all probability there would be a distinct reaction of certain varieties when grown in different sections. The number of potatoes submitted to the Nomenclature Committee, however, should be held to the very minimum, otherwise the members would not have the time or possibly the funds to handle them.

3. "I am of the opinion that it would be very desirable for all originators of new varieties to submit samples to the committee to study prior to introduction. If this procedure is followed, all the new varieties can be classified properly into their respective groups thereby avoiding confusing the public or the grower not familiar with the new variety."

Apropos of the desirability of a more thorough study of potato varieties it is especially interesting to note other comments on the subject. Under date of February 4, 1936, Donald Reddick of the College of Agriculture, Ithaca, N. Y., wrote the Secretary of the Association as follows:

"The appearance of Snell's and Fernow's articles in the same number of the Journal brings to mind a problem which must be met sooner or later in this country. Fernow admits he may have made a mistake in combining all the Cobblers and all the Peachblows. My understanding is that some of the Peachblows are seedlings and in consequence distinct varieties. Jehle tells me that the only McCormick now grown in Maryland is the White McCormick. Red McClure is regarded, especially in Chicago, as a potato of high quality. Fernow combines it with Peachblow. Lately, I have been told that Idaho Rural Charles Downing and British Queen are the same variety."

"The Germans have thrown out synonyms by fiat, the British have discarded them by common consent and we continue to tolerate them. Is it not time for the Potato Association to do something about it?"

The following excerpts taken from K. H. Fernow's com-

munication of June 25, indicate the nomenclature problems of State seed certification officials. These were discussed at a conference of the northeastern certification authorities which was held at the New Jersey College of Agriculture June 22-23, 1936:

"One question was with regard to the present usage in such cases as the Late Cobbler—to distinguish it from the ordinary Irish Cobbler. This discussion also involved the Nittany Cobbler. The consensus of opinion of those present seemed to be that these races of potatoes were so similar to the Irish Cobbler that it would be impossible to detect them as mixtures in the field and for this reason as well as for practical purposes they should not be reorganized as distinct varieties but rather as strains of the Irish Cobbler.

"In the case of the Rurals we have a group of varieties which are indistinguishable in the field. In such a case it would seem best to agree on some one name to cover the whole group and make no attempt to distinguish between different varieties. There was a strong feeling that an effort should be made to come to some agreement as to the proper name for each variety or group and eliminate synonyms. In the case of Smooth Rurals, for instance, some states name them as stated, others call them White Rurals, another group call them Rural New Yorkers and Canada recognizes them as Dooleys."

A study of the list of varieties certified by the various states and by Canada furnishes ample confirmation of the necessity of a careful varietal study from the nomenclatorial standpoint with a view to the elimination of synonyms and the adoption of standard varietal names.

The purpose of this paper is to present the nomenclature problems confronting the seed certification officials and in doing so to invite the cooperation of all who are interested in the attempt at a more uniform use of varietal names. The committee's task is by no means an easy one nor is it one likely to be completed in short order.

It is hoped that the following comments in regard to some of the questions raised will not be misconstrued as an attempt to anticipate the findings of the committee in regard to the application of two or more names of the same variety. In the first place, take for example the Delaware and Gold Coin of the Green Mountain group. The difficulty involved in determining whether these two varieties possess recognizable different characteristics is greatly

enhanced by the fact that one cannot be sure of getting direct descendants of the original stock. In regard to the Russet Burbank, it will be difficult to eliminate its synonym—Netted Gem—because of the place it holds in commercial channels. The problem of distinct types of the Triumph is capable of solution through the affixing of strain numbers. Idaho Rural is a synonym of Charles Downing but like the synonym Netted Gem, is so well entrenched in commercial usage that it will be difficult to abolish it. The British Queen as grown in the West is not true to name as it is the Up-to-Date. The true British Queen has white instead of purple blossoms.

A simple solution of the Rural situation is to call all the Smooth or White Rurals by the name of the original Rural variety, namely Rural New Yorker No. 2; and the russet types—Russet Rural.

It would be desirable for the committee to include in its activities the registration of new varieties, whether derived from seedlings or by mutation. In this connection it would be the function of the committee to study each new variety prior to its introduction with a view to determining whether it is a variety distinct from or superior to those already in commerce and, if not, to recommend discarding it as is now being done in Great Britain and Germany. The following excerpt from O'Brien's paper on "Potato Growing and Research in Scotland" published in Scientific Horticulture—the Journal of the Horticultural Educational Association—Vol. 4, pp. 30-37, 1936, indicates the extent to which the re-naming of old varieties was prevalent in Great Britain before the Registration Committee was organized. In this way there arose ninety-three synonyms for Abundance; ninety-four for British Queen; and one hundred and eighty-five for Up-to-Date.

Owing to the lateness of the organization of the committee it will only be possible to initiate some preliminary studies of the status of some of the members of certain potato groups this present season. What is obviously necessary for a careful study of some of the older varieties of potatoes is to locate reliable stock which is known to have been grown by the same individual since its introduction. In this connection the members of the Association can render the Committee a distinct service by notifying the Chairman or other members of the Committee of such seed sources.

SOME PRELIMINARY NOTES ON THE EFFECT OF PSYLLID YELLOWS ON SEED STOCK FROM INFECTED PLANTS

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Since psyllid yellows was first described by Richards (1), there has arisen a conflict of opinion regarding its transmission through tubers. Richards in 1931 stated, "In Utah, normal plants are obtained from tubers grown on psyllid-infested plants." In 1933, (3) he confirms this statement by saying, "Under no observed conditions have plants grown from tubers produced by infected parents and kept free from insects, shown symptoms of psyllid yellows either in the greenhouse or in the field." Metzger (4) also confirmed Richards' observations in 1934, stating, "Greenhouse studies over a period of six years have shown that the symptoms observed in the field are apparently not perpetuated by the seed." On the other hand, Shapovalov (5) states, "At least in some localities, psyllid yellows may be transmitted with the tubers." Because of this conflict, the question still remains unanswered as to whether or not this seed is fit for certification. In order to answer this question, observations presented below were made from time to time in the course of certification work as opportunity presented itself.

SEASON OF 1928

After a partial crop loss in 1926 and almost a total loss in 1927 in the Fruita district, the first problem which presented itself was the advisability of planting the seed produced in 1927 for the 1928 crop. Small samples of Irish Cobbler potatoes produced in 1927 were collected during the winter and planted in the greenhouse, together with a small check of certified seed. The results are presented in table 1.

The plants listed as abnormal did not show definite symptoms of any specific disease, but all of them lacked the characteristic growth of normal plants. The foliage was darker green, the plants were dwarfed in growth, and the stems and leaves were smaller than those of normal plants. The leaves were normal in other respects, showing no rolling, crinkling, stiffness or discoloration. Although the num-

TABLE 1.—*Greenhouse test of Irish Cobbler potatoes grown at Fruita in 1927*

Source	No Growth	Mosaic	Normal	Abnormal	Per cent Abnormal
Burch, Early-planted crop	..	5	1	4	40
Burch, Late-planted crop	1	4	1	4	50
Bader	..	..	4	6	60
Lytle (Certified check)	..	..	5	..	..
Carpenter	..	1	..	4	80
Osborne and Stout, Early	1	..	..	9	100
Osborne and Stout, Late	..	..	2	8	80
Total					61.67

ber of plants observed in this test is too inadequate to warrant any conclusions, it indicates that seed from psyllid-infected plants may, under some conditions, be weak. Tests were again conducted in the greenhouse in 1931-'32, 1932-'33, and 1933-'34, but only occasional plants showed weakness such as those in 1928 and few failed to germinate. This might be explained by the fact that subsequent infestations were not so severe as the one in 1927.

Following the greenhouse test, a field test was conducted at Fruita using four of the same lots of seed and eight lots of certified seed shipped from districts where psyllid was not present in 1927. The plots were planted on April 15, somewhat later than is customary in the district, and were harvested July 20. All plots in this test were seventy-five feet long and were replicated four times. A slight infestation of psyllid yellows was present in these plots. The significance of results was determined by Fisher's Variance method. The results of this test are presented in table 2.

From the above table it may be seen that there is no significant difference in the yield of seed from infected plants and non-infected plants. The entire crop for the Fruita district in 1928 was planted with locally grown seed, and from plants seriously infected in 1927. The yields for each acre were estimated at seventy-five per cent of normal in spite of a light psyllid infection in 1928, under favorable seasonal conditions.

An extensive survey of most of the seed being planted was made in the spring of 1928, in addition to the above observations. Along

TABLE 2.—*Yields of Irish Cobbler potatoes from seed of psyllid infected plants, and non-infected plants at Fruita, Colorado, in 1928*

Source	Condition	Replications Yield in Pounds				Mean	
		A	B	C	D		
Reinhardt	Non-infected	71	73	57	52	63.25	=6.114 of diff.
Watson	Non-infected	50	67	61	66	61.00	=4.32 Level of sig.
Hendrickson	Non-infected	65	64	56	47	58.00	8.64 Gen. mean
Sparks	Non-infected	60	60	55	55	57.50	54.21 Mean infected,
Osborne and Stout (Late)	Infected	52	68	55	54	57.25	51.75 Mean non-infected,
Burch (Late)	Infected	57	52	60	48	54.25	55.97
Lytle	Non-infected	46	60	52	55	53.25	
Walsh	Infected	47	61	49	55	53.00	
Newton	Non-infected	57	50	52	40	49.75	
Doherty	Non-infected	48	50	52	46	49.00	
Gosnell	Infected	54	54	41	45	48.50	
White	Infected	40	45	45	53	45.75	

with fusarium, rhizoctonia and scab, some of these lots of seed showed as high as five per cent of the tubers with no sprouts at planting time. About two hundred of these were held at room temperature for three months, and a small percentage showed spindle sprouts, and when cut these tubers showed severe net necrosis. The remainder showed no sprouts and very little wilting during this period, and when cut were hard and glassy. These tubers showed no outward abnormalities; in fact, they were usually perfect types.

During this epidemic another peculiar condition was also noted. The main axis of the plants was short, but the stem was often thicker than normal. The terminal leaflets were dwarfed, longer and more slender than usual, with yellowish and often purplish margins, slightly crinkled and showing mosaic symptoms. The tubers were small, often necrotic, usually sessile and more numerous toward the surface of the soil. Axillary growth was usually more active, producing leafy shoots even slightly below the surface of the soil. The lower axillary buds near the ground line often produced leafy shoots that were nearly as tall as the main axis. Personal visits with Goss and Werner in 1935 disclosed that this condition had been known as "haywire" in Nebraska for a number of years. In 1928, this disease was prevalent to the extent of fifteen per cent in one lot of certified Cobblers and was not observed in any other variety. Haywire and dormant tubers have been observed many times since and seem to be associated with psyllids. Badly infected fields at Fruita in 1928 were plowed up and planted to other crops. Plants showing light infections were sprayed and few, if any, psyllids appeared in the district in 1929, so further observation along this line was impossible at this time in this district.

In 1929, psyllid yellows appeared in epidemic form in the Gilcrest area, a small early district about four hundred miles from Fruita and separated from it by the Continental Divide. By 1931 it was appearing in widely scattered fields throughout the state. In 1932, inspectors of certified seed were again puzzled by the strange condition, later determined as identical with the Nebraska haywire. Greenhouse tests of many seed lots between 1931 and 1935 failed to reveal symptoms of haywire, but fields planted with the same lots of seed continued to show from 1 to 12.5 per cent. All of these seed lots came from districts that have been infected with psyllids practically every year since 1927, and showed some net necrosis and also some tubers which failed to sprout.

Season of 1933

A seed sample plot was planted in the San Luis Valley to demonstrate the value of certified seed to the growers. The plot was sponsored by the Colorado Extension Service and the Colorado Potato Growers' Exchange. In this plot were two lots of certified Brown Beauty seed from the same grower. One lot was grown beyond the edge of the main potato district on a well isolated farm but one that was severely infected with psyllids in 1932. The other lot was grown from the same seed on the home place in the center of the potato district and was not infected in 1932. It is unfortunate that there were no replications in this plot. The infected seed yielded 322 pounds of markets, 71 lbs. of seed for a total of 393 lbs. The non-infected seed yielded 430 pounds of markets, 57 pounds of seed for a total of 487 pounds.

Infected plants manifested peculiar symptoms throughout the growing season. They emerged a week later, grew more slowly, the main stems were weaker, the lower axillary buds produced branches as tall as the main axis, and the leaflets were smaller than normal but without any change in texture or color. These differences tended to disappear about September 1.

During the same season a test was made at the Mountain Substation from lots of seed which showed varying amounts of infection the previous season. Three lots each of the Lutz strain of Brown Beauty, and the Webster strain of Bliss Triumph grown in different parts of the state were used. No significant differences in yield between plots from heavy, mild, and non-infected seed were secured, and all the plants appeared normal during the growing season. Light and temperature relations suggested by Shapovalov (5) may account for this.

Season of 1934

In the San Luis Valley test plot of this year on the same farm as that of 1933, a lot of certified Triumphs was observed showing the same characteristic symptoms of weakness as the Brown Beauties of the previous season. This lot was from seed of a late strain severely infected with psyllids the previous season. The plots were three hundred feet long, but severe drought seriously reduced yields. The data were analyzed by Bessel's formula determining the probable error for a single mean. This lot was compared with another certi-

fied lot which was medium in maturity. The results of the 1934 test are presented in table 3.

TABLE 3.—*Yield of seed from infected and non-infected fields of Bliss Triumph*

Infected	*Non-infected*	PEd= 8.821
50.6	131.0	d =67.675
65.5 Mean 75.425±7.757	151.7 Mean 143.1±4.2	d
81.2	146.6 SE=6.227	— = 7.67
104.4 SE=11.5		PE

In this case the results are highly significant. A sample of seed from each of these lots was planted in 1935 with the following results:

		Total
Infected.....	1933, 295 lbs. markets 47 lbs. seed 5 lbs. culls	347 lbs.
Non-infected...	1933, 261 lbs. markets 37 lbs. seed 0 lbs. culls	298 lbs.

The vines were normal in vigor in 1935 also, which indicates that injury is not permanent, and injury to a lot of seed may be overcome.

SEASON OF 1935

The season of 1934 was one of severe drought and heavy psyllid infestation practically over the entire state, and the occurrence in the 1935 crop of the abnormalities previously noted was more frequent than in previous seasons. Many commercial fields of Brown Beauties and Bliss Triumphs in the San Luis Valley showed the characteristic weak vine growth previously noted. Tubers from infected plants often showed characteristic symptoms of infection consisting of premature sprouting and abnormal growths at the bud end. Brown Beauty tubers from an infected field were sorted into two lots and planted. One lot was normal, whereas the second lot showed the characteristic abnormal growths at the bud end as described by Richards and Blood (3) and Metzger (4). The two lots were planted in rows side by side. The abnormal lot showed the characteristic weak growth, whereas the other lot appeared nearly normal during the season. At digging time the rows were divided into four 50-foot plots each. The yield data were analyzed by Student's method for paired plots. The results are presented in table 4.

TABLE 4.—*Total yields from normal and abnormal tubers from a psyllid-infested Brown Beauty field*

Yield in Pounds		d	d^2	
Normal	Abnormal			
93	67	+36	1296	=15.03
94	88	+ 6	36	SE= 8.68
85	87	− 2	4	t= 1.50
98	86	+12	144	P= .2

From the above data it will be seen that the difference in yield of these two lots cannot be considered significant. There was also no significant difference in yield of potatoes passing through a 1⅞ inch screen from these two lots as is shown in table 5.

TABLE 5.—*Yields of small tubers from abnormal and normal Brown Beauty seed*

Yield in Pounds		d	d^2	
Normal	Abnormal			
37	29	+ 8	64	=5.148
41	26	+15	225	SE=2.97
30	28	+ 2	4	t=2.34
46	43	+ 3	9	P= .1

The epidemic of 1934 extended to the Mountain Substation where the commercial fields and varieties under test were severely infested with the insect. Russet Burbanks apparently suffered most severely. A lot of certified seed from Washington state was compared with the stock grown at the station in 1934. The results are presented in table 6.

TABLE 6—*Yields from infested and non-infected Russet Burbank seed at the Mountain Substation*

Yield in Pounds		d	d^2	
Non-infected	Infected			
131	87	44	1936	= 7.089
144	91	53	2809	SE= 4.09
121	88	33	1089	t=10.64
126	82	44	1936	odds over 100:1

The difference in yield in this test is very definitely significant. The plots were one hundred feet long, single row, and planted next to one another. The vines in the infected plots showed the characteristic weakness associated with psyllid-infested seed under some conditions as noted in former years. In addition to the weakness of vines, the stand was only sixty-eight per cent as compared with ninety-two per cent for normal seed. In most cases the loss in stand was caused by the formation of sprout tubers instead of tops. Peachblow, Katahdin and Chippewa showed very little weakening in growth or loss in stand, but Rural New Yorker No. 2 and certain seedlings showed both troubles.

DISCUSSION

The data presented here are inadequate and highly contradictory. No standard plot size, plot layout or method of analysis was possible because of the periodic nature of the trouble, and the failure of the abnormalities to appear consistently from infected seed. The data indicate, however, that under certain conditions the seed may be seriously injured. These particular conditions are not understood at the present time. The extent of injury to the seed may be caused by the population of insects infesting the plants, the length of time they feed on the plants, or several successive seasons of infestation may be necessary to produce the damage noted in some instances. It may also be possible that the insect in itself is incapable of producing the severest types of damage, but does it in conjunction with high temperatures and drought. The conditions under which infected seed are planted may also influence results. In all cases where sig-

nificant differences were observed, the infected seed was planted in the same locality in which it was produced.

Although there are some similarities between psyllid yellows and haywire, the differences are great enough to render them readily distinguishable, even though they have often been confused even by trained inspectors. Observations in Colorado indicate that the transmitted disease obtained by Shapovalov (5) was haywire, although more work is necessary on this entire problem to confirm the meager observations already presented.

Conclusion

Sufficient evidence has already been presented to show that damage to seed from psyllid infestation may occur under certain environmental conditions, and that it is dangerous to certify fields showing more than fifteen per cent of mild symptoms of psyllid yellows on second inspection. This tolerance was adopted in Colorado beginning with the season of 1934.

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NOTES AND BRIEF ARTICLES

A MARKETING PLAN FOR PENNSYLVANIA POTATOES

The potato marketing program that has been under discussion in Pennsylvania for some time has finally taken form and is now being organized and put into operation. Since the last annual meeting of the Pennsylvania Co-Operative Potato Growers' Association in January, the Board of Directors of the Association has held numerous meetings and conferences with representatives of the mercantile organizations and other interested agencies. As a result of these discussions the following plan was devised for marketing Pennsylvania potatoes in the most efficient manner:

(a) By determining a standard grade high enough to meet exacting demands for all practical consumer acceptance and yet low enough to make the best of our local crops.

(b) By adopting and tradesmarking a distinctive, practical and attractive pack of a size to meet the widest market demands.
(c) By determining definitely and accurately the merits and qualities of our own potatoes.
(d) By determining the true status of the potato in the diet of the normal and subnormal person.
(e) By determining and developing varieties most adapted to our growing conditions and most suited to special culinary uses.
(f) By setting up machinery by which the grading and packing of the adopted brand will be guaranteed to the consumer and made available in sufficient volume to interest large purchasers.

The cooperating agencies will be the Pennsylvania State Potato Growers' Association and members of the various mercantile organizations. They will be called sustaining members when they have become active in defraying their proportionate share in the prosecution of the project.

A committee composed of five representatives chosen from sustaining members of various mercantile organizations and five Directors of the State Potato Growers' Association shall constitute the Joint Conference Committee. Representatives from the Pennsylvania State College and the State Department of Agriculture shall be asked to participate in an advisory capacity in all conferences of the committee.

It shall be the duty of the Joint Conference Committee to consider all matters which pertain to the efficient operation of the original conception of the project. The recommendations of the Joint Conference Committee shall be final and binding in so far as they pertain to the spirit of the project.

A Secretary and General Manager shall be employed by the Board of Directors of the State Potato Growers' Association and shall be responsible to this Board in all activities commensurate with this office. E. B. Bower, with headquarters at Bellefonte, has been employed as the General Manager.

The marketing plan has been under discussion for some time and valuable contributions to the plan were made by J. W. Warner, County Agent of Indiana County, and Fred W. Johnson. The plan gained impetus when the Potato Growers' Association was approached last November by certain large purchasing organizations, to determine if it were not possible to work out some arrangement whereby Pennsylvania potatoes could take their proper place on the markets. Through this contact the Pennsylvania potato growers have been offered preferential treatment in the marketing of their potatoes through

all the members of the Food Distributors' Association which includes most of the retail and wholesale organizations in the State.

Following many conferences and a thorough discussion of all the possibilities the following procedure for participating in this marketing plan was developed:

1. The grower or group of growers desiring to market under this project must agree in writing to meet the trade standards for all potatoes marketed under the adopted brands.

2. All potatoes sold under this marketing project must be packed in the Pennsylvania Cooperative Potato Growers' Association trade-marked bags.

3. Individual growers or groups of growers selling under the trade-marked bags shall place on the bags their individual names, group names, or trade name.

4. The grade of potatoes packed in the Association "trade-marked" bags must be certified to by a qualified inspector authorized by the Association.

5. Mechanical sizing and grading may be done at centralized grading stations by a crew moving from farm to farm or by the grower under the directions of an authorized inspector.

6. Each community or centralized grading point must select a contact man with whom the Association office can communicate relative to price and movement of crop.

7. In order that the Association office may know the number of bushels of potatoes available for sale under the marketing project, the individual grower must register the estimated number of bushels he desires to sell through the Association.

8. The Pennsylvania Cooperative Potato Growers' Association shall collect the best available crop and market statistics and disseminate the information as far as practical.

9. After taking all available facts into consideration, and upon recommendation of the Joint Conference Committee, the Directors of the Potato Growers' Association, adopted the 60 pound and 15 pound paper bags.

10. They also adopted the two-inch minimum and a "Sensible" pack (i.e., one that the consumer would like to repeat) put up under the Blue Keystone.

11. A medium size—one and a half inch to two inches, smooth and regular, equal to or superior in all respects except in size to the Blue label, to be put up under Red Keystone. Nothing in the discussion would discourage any county or section from increasing the mini-

mums of these two grades. On the other hand, this should be encouraged, and it is contemplated that this will be done at the beginning of the next crop year. There will be adequate and timely information on the packs and packages as the season advances. The Association charges no commission for this service; the purchasers of the potatoes charge no commission for buying.—K. W. Lauer.

CERTIFIED POTATO SEED FOR THE SOUTHERN GROWER

Julian C. Miller

Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana

The importance of using the best available seed cannot be overemphasized to any group of growers. The southern grower buys seed each year and, because of the long freight haul, has a greater cash outlay than the northern grower. The price usually paid for seed in the South varies from $2.75 to $3.75 per hundred pounds, when delivered. The southern grower has other items that must also be considered which are not so important in the North; that is, the larger amounts of fertilizer used the lower yields usually obtained. Considering the above items, the southern grower must take every necessary precaution in order to obtain seed having the potential qualities to produce the highest yields. This means that the seed must be as free as possible from disease, especially seed-borne virus diseases.

For the past twenty years, the Louisiana horticultural workers have kept in close contact with certified seed developments, and each year a number of lots of potatoes from the different seed-producing areas are grown primarily for making disease counts and in some cases for yield comparisons. Through tests of this nature and by working in cooperation with the experiment stations and seed organizations of the seed-potato-producing states, we have been able to locate the sections producing the best seed as well as, in many cases, the better growers. The Louisiana seed potato regulations state that seed being offered for sale for planting in the state must not contain over 5 per cent total virus diseases and not over a total of 6 per cent of all diseases which cannot be controlled by seed treatment. These requirements have a wider range of tolerance than most certified seed regulations in the different states. For some reason there have been

only three seed potato producing states capable of growing commercial seed stock sufficiently free from disease to pass the above regulation when the readings have been made on plantings of potatoes grown in Louisiana. The degree of perfection obtained in potato seed production in any given state depends upon several factors, (1) principally the knowledge of the fundamentals of potato seed requirements by the men in authority, (2) the effectiveness of their methods in teaching growers these fundamentals, and (3) the strict enforcement of the regulations of the inspection service.

The apparent difference in the uniformity, type, and freedom from disease of the same variety from different sources is evidence that there is a lack of correlation in the factors above mentioned, or otherwise we must credit this difference to natural climatic conditions of the sections where the seed is grown.

In the past, even where disease was not a factor, we have received numerous reports regarding differences in earliness and in the yielding ability of seed potatoes of the same variety produced in different localities. Recent investigations by the writer would lead one to believe that this difference in time of maturity and yielding ability is not caused entirely by environmental conditions under which the seed was grown, but to the time the potatoes were harvested. There is as much as a month's to six weeks' difference between the time of harvesting in the various seed-producing areas of the North. This difference in addition to the influence of various types of storage conditions which may hasten or retard the rest period, has a marked influence upon the type of growth when planted in the South. Seed from early-harvested areas naturally germinate and mature more rapidly than seed from areas which have been harvested later. In some cases, earliness is not always an advantage since yields from seed which has been harvested later and which had a shorter dormant period are usually larger.

The questions discussed above make the source of seed a complicated problem for the southern grower. We of the South congratulate the investigators and growers of the northern seed-producing areas for the excellent progress they have made and for the high quality of seed which we are now receiving. And in the future, we are looking forward to closer coordination and cooperation in research, and other means for potato improvement.

THE ATLANTIC CITY MEETING

The annual meeting of the Potato Association of America will be held at Atlantic City from Tuesday, December 29, to Thursday, December 31.

Joint sessions have been arranged with the American Society for Horticultural Science on Tuesday afternoon, December 29, and with the American Phytopathological Society on Thursday afternoon, December 31. All of these associations will meet in the Atlantic City Auditorium.

The Tuesday and Thursday morning sessions of the Potato Association will be held in Committee Room 4 and the Wednesday sessions in Committee Room 6.

Railroad Rates

Due to the recent reduction in passenger rates in the East, it is doubtful if special convention rates will be available.

Hotel Headquarters

The Ritz-Carlton has been designated as the headquarters for the Potato Association and the American Society of Agronomy. The rates are $3.00 to $5.00 for single rooms and $6.00 to $10.00 for double rooms, with twin beds. The Hotel Ambassador, with the same rates, will be the headquarters for the biological societies. The Franklin Inn, Morton, Princess, New Belmont, Sterling and Thurber list single rooms at $2.50 and double at $4.00. The Kentucky and Richfield list single rooms at $2.00 and double at $4.00. The A. A. A. S. General Headquarters will be at Haddon Hall, Registration Headquarters at the City Auditorium.

Papers to Be Presented

Titles of papers to be presented should be in the hands of the Secretary on or before November 10. In submitting papers the author should give (1) title of paper, (2) name and affiliation of author, (3) time required for presentation, and (4) whether or not a lantern is required.

Manuscripts should be submitted to the Secretary at the time of the meeting. These will be printed in the American Potato Journal during the year 1937.

The article on "The Problems of Potato Breeding" by S. M. Bukasov, U. S. S. R. Institute of Plant Industry, Leningrad, Russia, which appeared in the September issue of the American Potato Journal, Vol. 13, No. 9, was translated by Miss A. Trost.

SECTIONAL NOTES

CALIFORNIA

The Stockton district of California has marketed the major portion of its crop. There are probably 1200 cars left in the district but the quality is not very good.

The only potatoes left in California are in the Klamath Irrigation District bordering the Oregon line. The Klamath district, as a whole, will produce nearly 7500 cars this year of which 1500 cars have already been marketed. The balance of the potatoes which are of very fine quality, will be placed in storage under favorable conditions. (Oct. 12).—H. G. ZUCKERMAN.

COLORADO

All the Colorado potato growers are being agreeably surprised by the yield and quality being obtained this year. After a very poor growth because of the severe drought durng May, June and the greater part of July, the potato crop is exceptionally good. In fact, the crop is better than any crop since 1930. Timely rains during the latter part of July saved the crop after supplies of irrigation water were becoming exhausted. The yields that are being obtained are almost unbelievable, ranging in the San Luis Valley from 270 to 440 sacks per acre on unofficial yields. Carlot shipments to date are one-third ahead of the same time last season, and shipments still continue heavy because storage space for the large crop is not available. Harvesting will not be completed until the latter part of this month.

Prices have remained very satisfactory although heavy shipments have been made. F.o.b. cash track prices range from $1.25 to $1.50 per 100. Two large track-side warehouses of the Colorado Potato Growers' Exchange are now equipped for washing and sufficient stock is being washed to warrant special quotations on the Chicago market. Washing started with the movement of Triumphs in the latter part of August, and is being continued with the late varieties. Washed stock is bringing a premium of 10 to 30 cents to the 100 on the Chicago market.

Most of the growers in the larger districts sprayed for potato psyllids, and damage from this insect, in general, was much lighter than in the previous seasons. Early blight and a heavy infestation of aphids which rarely occur in large numbers in Colorado, reduced the potato crop in the San Luis Valley quite materially. Although condi-

tions were unfavorable, Colorado appears to have a record crop this year. (Oct. 13).—C. H. METZGER.

INDIANA

Naurally, high prices will stimulate production and from our anticipated acreage increase for 1936 it looks as though Indiana's acreage would equal approximately 75,000 acres for 1937 or a little more than the normal trend. Our acreage was reduced this past year because of lack of good seed but no doubt will recover and add 2,000 or 3,000 additional acres. This will be used mainly for home consumption. We will need several thousand bushels of good seed, mostly Cobblers, Ohios, and Rurals. (Oct. 8).—W. B. WARD.

IOWA

The Potato Association of America had no member more devoted to the study of the potato plant and to the welfare of the potato industry than was Edward D. Askegaard of Moorehead and of Comstock, Minnesota. Mr. Askegaard died in June, after a long and brave fight with cancer of the throat. On August 28, a group of Association members, while attending the potato breeding tour in the Red River valley, called upon Mrs. Askegaard at her home in Moorhead. We failed to see the daughter, who is a grown woman; and the son, who is a freshman in the Agricultural College of North Dakota. By the way, Mrs. Askegaard's son ranked first in his class, and fifth among the fifteen hundred students last year. Their father left them a heritage of honor and of keen ability as students.

Among the people who called upon Mrs. Askegaard were: J. C. Miller, of Baton Rouge, La., President of the Association; A. G. Tolaas, former president; J. G. Leach; F. A. Krantz; F. J. Stevenson, of Washington, D. C., and C. L. Fitch.—(C. L. FITCH).

LOUISIANA

Because of the very satisfactory prices received for potatoes this year and also because of the shortage of the potato crop in most sections of the North, the general outlook for potato prices for the South next spring is good. For this reason there has been a great deal of activity recently in arranging for purchasing seed for the spring crop. There would be a big increase in planting if it were not for the fact that good seed is scarce and prices relatively high. With these factors to be considered, it is still estimated that there will be an increased planting in the South. (Oct, 12).—JULIAN C. MILLER.

MASSACHUSETTS

The potato crop in Massachusetts is practically harvested. The September estimate of the New England Crop Reporting Service was 2,300,000 bushels from 16,500 acres. The yield is slightly above last year's crop from a larger acreage and considerably above the average for the period 1928-1932. Among the better commercial growers, yields have been high with a considerable number averaging 400 bushels and more for their entire acreage. The highest yield in the Massachusetts Potato Club, officially weighed from the entire acre, was 597 bushels. This crop was sprayed thoroughly fourteen times with four nozzles to the row.

Prices continue very satisfactory at approximately the same level of $1.60 to $1.70 per hundred pounds. With no seed stock produced in Massachusetts, the present outlook for seed for next year points to rather high prices, with farmers in Maine apparently unwilling to quote in anticipation of some shortage. (Oct. 14).—RALPH W. DONALDSON.

MINNESOTA

Potato harvesting in Minnesota has been completed, and from our observations it would seem that the production in the state will be considerably lower than in 1935.

Yields, ranging between 40 bushels to the acre in some sections to 250 bushels to the acre in others, vary with the locality. Recent reports from the Red River Valley indicate that the production this year is probably less than 50 per cent below normal. The production in the Arrowhead section ranges from 60 to 65 per cent normal, whereas the average production on the peat soils is very close to normal. Last year freezing weather arrived while many crops were still unharvested and as a result a considerable amount of freezing injury occurred, making proper grading almost impossible. This year, however, there will be little, if any, injury from freezing; and although the potatoes in many sections will be small, the quality will be good.

The greatest reduction in yield occurred on early-planted fields, particularly those planted with early varieties. The extreme heat and drought prevailed at the time of tuber formation, and many such fields were left unharvested. Because the weather was more seasonable in August and early September, later planted fields grew fairly well.

Although we inspected a larger acreage of potatoes for certification this year than in 1935, the total production will be considerably less than it was last year. The statistics on potato certification work in Minnesota for 1936 are given in the table below. We have not yet obtained enough yield reports to get an accurate estimate of the production of these fields. (Oct. 13).—A. G. TOLAAS.

Variety	*Acreage Inspected*	*Acres Rejected or Withdrawn*	*Acreage Passed*
Bliss Triumph	1,906.50	57.0	1,849.50
Irish Cobbler	5,425.77	688.25	4,737.52
Early Ohio	623.34	65.50	557.84
Warba	401.99	5.75	396.24
Chippewa	73.40	7.45	65.95
Green Mountain	116.86	52.0	64.86
White Rose	389.75	42.50	347.25
Russet Burbank	24.80	15.0	9.80
White Gold	24.0	1.0	23.0
Golden	.1	0.	.1
Katahdin	23.62	4.0	19.62
Rural New Yorker	8.0	0.	8.0
Russet Rural	1.5	.5	1.0
	9,019.63	038.95	8,080.68

NEBRASKA

Western Nebraska dry land potato yields for 1936 have indicated the most serious crop failure that growers have ever experienced. A great majority of the acreage will not be harvested and a conservative average yield for the fields that will be harvested should give approximately 14 bushels to the acre. Hot, dry winds and excessive insect damage stunted the vines at so early a date that they were beyond recovery during the last few weeks of cool weather, which prevailed prior to our first killing frost.

The irrigated section has a fairly good crop of exceptionally good quality Triumphs. Yields were decreased to a certain extent because of poor stands caused by the excessive heat in early July as the plants were first emerging. Yields will average about 200 bushels to the acre in the North Platte Valley. (Oct. 9).—PHILLIP A. HOFF.

NEW HAMPSHIRE

Potato digging is progressing very rapidly and should be completed within a week or ten days, except in a few isolated cases. The crop in northern New Hampshire is of exceptionally high quality and is producing a good yield. Members in the 300 Bushel Club in this area have averaged over 400 bushels to the acre. In the central part of New Hampshire the crop is apparently somewhat reduced although the quality is good. In the southern part the yields are fair. Variations in yields are accounted for, in part, by the fact that the rainfall this season has been confined, to a large extent, to local showers.

Very little loss will be experienced this year through rot, scab, second growth or growth cracks. Much care is being exercised in harvesting the crop to prevent bruising and a large percentage of the crop should be of a marketable type.

Commercial potatoes are selling in northern New Hampshire at 70c f. o. b. shipping point. The local retail sales range from $1.00 to $1.25. (Oct. 8.)—DAN O'BRIEN.

NEW YORK

The yield of potatoes in New York this year varies widely according to locality and conditions. Even locally the yield is "spotty". Northern and eastern New York are the only regions where the yield will be normal and these areas are not those of extensive production. Muck growers did not harvest more than 80 per cent of a normal crop. Throughout the state, with the exception of northern New York, there will be a high percentage of stock graded below No. 1 grade. Misshaped and small tubers are much in evidence. This is a year when top growth is not a fair indication of yield.

Harvesting operations have been delayed in western New York and will be at least two weeks late because the grower's desire is to let the plants mature. Many fields will be harvested while immature which means more mechanical injury and an increased shrinkage in storage. Although a little late blight has been reported in northern New York, none has been noted in the rest of the state.

Digging demonstrations are being held in six counties to show growers how bruising may be eliminated by proper digging operations. A big increase in new diggers of the continuous apron type has been noted.

This year approximately 20 variety tests are being harvested in twenty different counties for the purpose of comparing the new varieties with the old standards. To date, the Chippewa has given results superior to all other early varieties both on muck and upland. The Warba yielded about as well as the Chippewa on muck but not on up-

land. The Houma variety compared favorably with the Rurals considering the drought which prevailed in western New York. (Oct. 13). —E. V. HARDENBURG.

OHIO

The late potato crop which was planted late has remained green and this has caused a delay in harvesting. Light frosts in northern Ohio have done little damage to the tops. The heavy rains which have prevailed during the last week have also delayed harvesting.

The crop is estimated at 12,000,000 bushels. The set is light and the potatoes in general, are large. The yield and quality in northeastern Ohio will be good.

We are starting a comprehensive study of the potato situation and expect to gather considerable data on digger injury and other defects that are preventing potatoes from meeting U. S. No. 1 grade. The Federal-State Inspection Service will cooperate in this work, and provide inspectors to make the inspection after the samples are taken in the field. This study will be facilitated by the cooperation of local grading and marketing organizations. (Oct. 12).—E. B. TUSSING.

SOUTH DAKOTA

Two hundred and seventy acres of potatoes were entered for certification. Of this number about 140 will pass as good certified seed, yielding anywhere from 75 to 100 bushels to the acre—some perhaps more. There will be about 50 acres of good seconds which were only slightly over the tolerance for one or more of the diseases mentioned later. These should yield 75 bushels or more to the acre.

Factors which determine whether or not certified fields would pass inspection were wilt, drought, insect injury, and spindle tuber. Many fields of potatoes from good stock had to be rejected because of drought and insects. Wilt was also quite prevalent in many fields. The average for the fields inspected was approximately 10 or 15 per cent. Some fields of ordinary run potatoes showed as high as 60 to 80 per cent wilt. Since some excellent strains were imported last spring, a few small fields which were rejected will possibly furnish good seed, but it will be impossible to make disease readings.

In general, the potato crop is surprisingly good in the eastern one-fourth of the state owing to late summer and early fall rains which came in time to save many fields, especially the late-planted ones. The early-planted ones are producing a large number of ill-shaped tubers which cannot be satisfactorily graded. This is especially true of the Early Ohio variety, which is very popular among the general class of farmers. (Oct. 12).—S. P. SWENSON.

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in 1931 and 1933. According to records of the United States Weather Bureau, both of these years were characterized by excessive heat and drought of early summer in the principal producing areas of Wisconsin. Similar conditions also prevailed in late summer, with the exception of generally favorable precipitation in 1931. Therefore blackening after cooking became conspicuous for a period of years (1930-1933) when the availability of mineral nutrients should have been depressed by dryness of the soil and plant metabolism should have been disturbed by high temperatures. Another factor which should be considered as contributory to this crop condition is the probable curtailment of fertilizer purchase in a period of economic depression.

Blackening of cooked potatoes is not a subject of entirely recent observation. As early as 1921, Wallace (2) reported this abnormality in one of two varieties which had received manure reinforced by nitrogenous fertilizers, following a hot, dry summer. The trouble was largely eliminated by the addition of a low plane of potash to the other manuring. Somewhat later Merkenschlager (3) examined tubers that were grown without application of potash, and which blackened after cooking. He ascribed the abnormality to unusual activity of the oxidizing enzyme tyrosinase in the raw tuber, in conjunction with accumulation therein of the amino acid tyrosine. This investigator recognized the possibility that this system might form products spontaneously oxidizable to dark colored pigments when the cooked tissue was exposed to the air. The work of Raper (4) had already disclosed the conversion of tyrosine ($C_6H_4(OH)CH_2CH(NH_2)COOH$) to dihydroxy-phenylalanine ($C_6H_3(OH)_2CH_2CH(NH)^2(COOH)$) by tyrosinase, with subsequent formation of dihydroxyindole ($C_8H_4(OH)_2(NH)$). This last compound undergoes further changes to form the pigment melanin.

The nitrogen content of tubers in relation to blackening after cooking.

Reference has already been made to evidence that nitrogen-carrying fertilizers aggravate this abnormality of the potato. A considerable number of both normal and abnormal samples in our collection was subjected to the determination of total nitrogen content. For this purpose, the familiar Kjeldahl-Gunning procedure was applied, using mercury as a catalyst. The average percentage of nitrogen in the dry matter of peeled tubers was 1.69 for potatoes which remained white, as compared with 1.87 for those which blackened. It should be observed that these averages were derived from wide and overlapping ranges, namely: 1.08 to 2.04 in the normal, and 1.48 to 2.22 per cent

in abnormal tubers. From a similar study at the Michigan Experiment Stations (5) the conclusion was drawn that no correlation existed between nitrogen content and discoloration after cooking. We are inclined to qualify the deductions based on our limited experience. Apparently, higher nitrogen content may be a factor associated with other conditions to cause blackening of some potato crops.

Other aspects of tuber composition in relation to blackening after cooking.

By a procedure of extraction with 50 per cent alcohol, the sugars and amino acids of the pared, raw tuber, were separated from their condensation products, namely: starch and protein. Similar treatment was applied to boiled samples of the same tubers. In the latter case, the solids removed in the boiling water were recovered, by distilling *in vacuo*, and thoroughly incorporated with the mashed tissue. The tubers were sectioned lengthwise so as to include similar proportions of the stem end in both of these samples.

In view of the findings of Roxas (6) and of Gortner and Holm (7) it appeared desirable to determine the contents of simpler reducing sugars and free amino acids of the tuber. The results of these investigators indicate some possibility that condensation products between these constituents, involving particularly the amino acid tryptophane, may be responsible for the pigmentation of cooked potatoes. Because of the possible roles suggested for them, tyrosine and tryptophane were subjected to individual determinations.

A. Comparison of raw potatoes.

Relatively wide fluctuations of the various constituents were found, in terms of percentages of the dry matter, but this response applies much more distinctly to the sugars than to the amino acids. The average contents of free alpha-amino nitrogen, tyrosine and tryptophane were 10, 25, and 20 per cent greater respectively in the abnormal than in the normal samples. Final conclusions can hardly be formed until more data are accumulated. The results indicate relatively incomplete condensation of amino acids, especially of tyrosine, in the potatoes which blackened on cooking.

B. Comparison of boiled potatoes.

As previously stated, the sampling treatment included in each instance a like proportion of the stem end of the tuber, where discoloration is generally most pronounced. Perhaps the compositional response to boiling can be most effectively considered in terms of the shift from conditions in the raw state. These values are quite variable, but more so for the abnormal than for normal tubers. Apparently

further efforts should be made to standardize the conditions of boiling and recovery as a means to reducing variability of composition.

In view of the conditions just considered only changes of the order of 15 to 20 per cent minimum have been considered as probably significant. On this basis, the normal potatoes remained essentially constant in sugars and soluble amino acids whereas the blackening potatoes lost moderate proportions of these constituents in boiling. On the other hand, both tyrosine and tryptophane increased appreciably in the normal potatoes but remained essentially constant in those subject to blackening. The failure of accumulation of tyrosine in the abnormal tubers in cooking may be in part interpreted as caused by extensive, previous liberation and partial oxidative conversion of this constituent while the tissue is in the raw state. This oxidative process is probably completed during the cooking treatment.

The relation of immaturity to blackening of cooked potatoes.

In a limited survey of tubers dug two to three weeks before full death of the vines we have found no correlation between immaturity and blackening of the cooked tissue. Selected chemical determinations disclosed no consistent compositional response of such potatoes to the cooking treatment. In some instances, the percentage of free amino acids was less than in mature tubers, a relation which has been reported by Appleman and Miller (8). This condition should serve to reduce the probability of the discoloration in immature potatoes.

The relation of storage conditions to blackening of cooked potatoes.

Potatoes taken from storage in advanced stages of sprouting commonly blacken seriously after cooking. The effect is largely localized in the "eye" regions, as would be expected to follow upon enzymic cleavage of tuber protein in those places. Such a response in the late spring must be ascribed to the breaking of dormancy rather than to unfavorable factors in the storage conditions. However, under anaerobic conditions, free amino acids accumulate in embryonic tissues (9). Also, high temperatures hasten the breaking of dormancy in potatoes (10) and therefore may be expected to induce the liberation of tyrosine and other amino acids. These considerations made it appear desirable to test the possible effects of temperature and ventilation differences upon blackening after cooking.

The best available tuber supplies of Russet Burbank and the varieties most extensively grown in Wisconsin were obtained from the 1934 crop. These were supplemented from the yields of field plots of the

Rural New Yorker which had been produced either from blackening "seed stock" or on a deficient supply of soil potash. A portion of about one-half bushel of each sample was stored in burlap sacks, a condition which should have favored rather normal respiratory exchange of gases. For essentially anaerobic conditions, paraffined cartons were used. These were cylindrical in shape and of about 0.5 peck capacity. Each was filled with closely packed tubers, avoiding pressure, which might injure the tissue. The fissure between cover and container was sealed by electrician's tape. These poorly ventilated samples were replicated so that a separate carton was available for each date of analysis. Storage differences which were applied included temperatures of about 21° C (70° F) and 4° C (39° F), in addition to the aerobic and anaerobic conditions. Samples of the several tuber stocks were analyzed from both the raw and boiled states during early November, the time of setting up the experiment. Similar examinations were made during January and March, covering the various conditions of storage. In all cases the color after cooking was noted. This study was repeated on a somewhat reduced scale with potatoes from the 1935 crop.

The results indicated that neither storage temperature nor degree of aeration is a primary factor affecting blackening after cooking. Differences in compositional responses in the two years were marked, and of a nature to suggest that they were produced by differences in the cultural history of the crop as well as storage conditions. These latter issues require further study for the development of conclusive results.

The relative stability of proteins from normal and abnormal potatoes.

From the evidence already presented concerning the content of free amino acids it appeared that the protein of the abnormal potatoes might be less firmly condensed than usual. If this condition existed one might expect that the protein of the abnormal type of tuber would liberate amino acids more readily under the action of hydrolytic agents than would that of the normal type of tuber. A difference in this respect should be sought especially in the case of tyrosine, for there is evidence (11) that this amino acid occupies a relatively exposed position upon the colloidal aggregate or molecule of some proteins.

For the preparation of protein, washed tubers were ground to a fine pulp in a Nixtamal mill (a type equipped with worm-fed, corrugated plates). Water, somewhat in excess of the tuber weight, was added during the grinding and accumulation of the extract. Exposure of

the tissue to the air was partly avoided by prompt transfer to the water. Sodium chloride was added to give approximately a five per cent solution in the diluted sap. After stirring for about 0.5 hr., the extract was squeezed through muslin. It was then exposed to temperatures of 0 to 4° C (32-40°F) for about 2 hours, to allow sedimentation of starch. Dialysis of the salt solution under ordinary conditions, proved infeasible, as indicated by apparent enzymic loss of tyrosine during the process. The liquid was siphoned away and heated by a current of steam to 70° C for coagulating the protein. After filtering and washing with salt solution, the precipitate was dried by washing with alcohol of increasing concentration, followed by ether. Although such preparations were decidedly crude, further purification appeared inadvisable, because of the risk of unduly modifying the protein. The total nitrogen content ranged between the general limits of 12 and 14 per cent.

Various preparations of the sort described were hydrolyzed by 3 per cent NaOH at 37°. This agent has the advantage of reducing losses caused by humin formation (12) as brought about by acid hydrolysis. From time to time, aliquots of the digesting fluid were removed and the protein was precipitated by trichloroacetic acid. The total group of compounds reacting like tyrosine with the phenolic reagent of Folin and Ciocalteu (13) was determined in the filtrate.

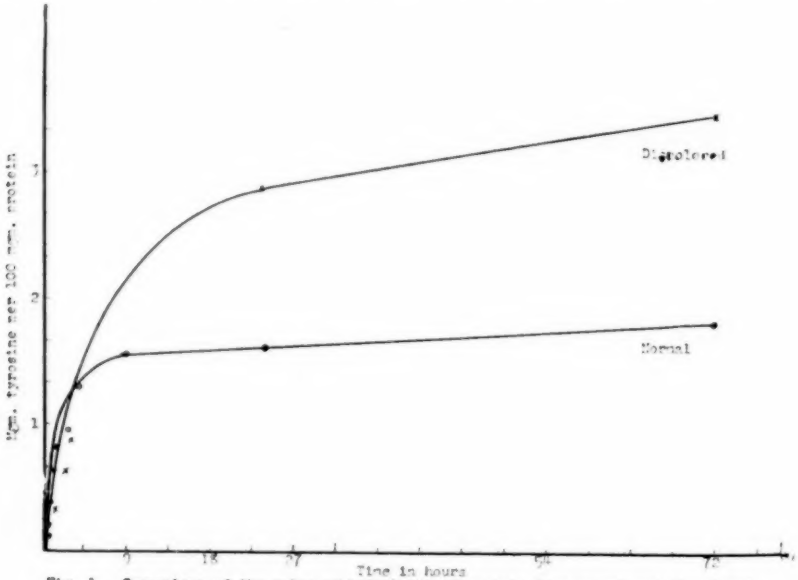

Fig. 1. Comparison of the rates of hydrolysis of protein from normal and discolored potatoes by NaOH at 37°.

The normal tubers used as sources of protein were of several different varieties, whereas those which blackened after cooking were chiefly Rural New Yorkers. Graphs giving a comparison of average results are shown in fig. 1. These graphs indicate relative instability of the protein in association with blackening.

Similar tests were applied in which the preparations were tested in boiling water only, for a period of twenty minutes. In these cases, use of the general run of tubers from both a normal and a discoloring sample of Rural New Yorkers gave little differentiation. The tyrosine equivalent increased 32 and 38 per cent in the respective samples. On the other hand, tubers of the same variety, produced on different levels of potash, and indexed for blackening after boiling, gave a marked difference in response of the isolated protein. The preparation from abnormal tubers yielded a 63 per cent increase of tyrosine equivalent in boiling water, when compared with 24 per cent for that from the normal tubers.

As a means of avoiding denaturation of the protein, further tests were made of the release of tyrosine equivalent by proteolytic enzymes. Inasmuch as preliminary tests with an enzyme from a foreign source (papain) were unproductive, through failure to secure appreciable hydrolytic activity, recourse was taken to a study of autolysis. Reasonably consistent results were obtained by the latter procedure only

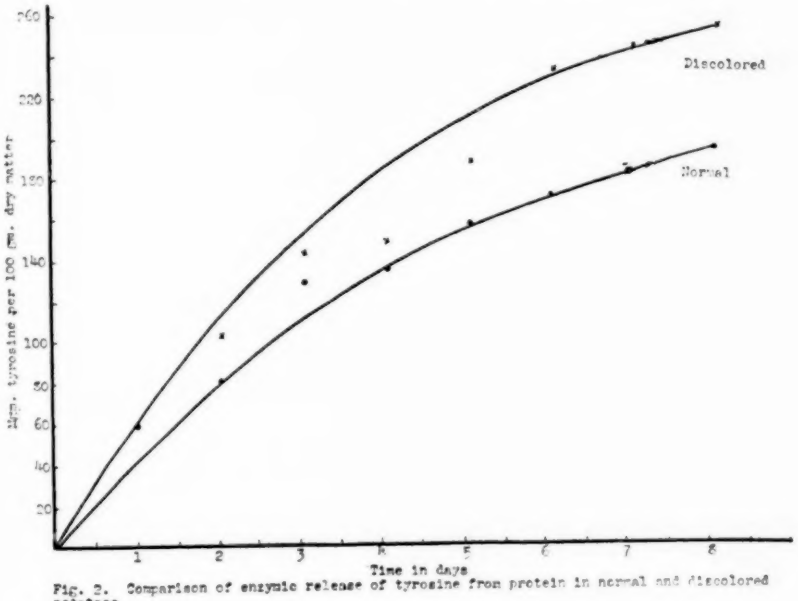

Fig. 2. Comparison of enzymic release of tyrosine from protein in normal and discolored potatoes

after exercising unusual care to prevent oxidation in the preparation and sampling of digests. An average of three such tests gave an increased liberation of tyrosine equivalent in tubers which blackened after cooking, when compared with normal tubers. The results are shown graphically in figure 2. Similar but less extensive changes occurred in the total amino acids, as represented by the determination of alphaamino nitrogen. It must be recognized that this test is as much a determination of proteolytic activity of the tissue enzymes as of instability of its protein. These several results seem to demonstrate significant causes for increased freedom of tyrosine and other pigment-forming amino acids in potatoes which blacken after cooking

The supply of potassium as a factor in potato blackening.

The apparent possibility that potato blackening is related to incomplete condensation of amino acids led to consideration of the potassium content of soil and tubers as a factor in the problem. Loew (14) early directed attention to the function of this element as an efficient agent in condensation reactions, and suggested by analogy a similar role in plant metabolism. Evidence for the support of such an hypothesis appeared in the recent work of Hartt (15) and Nightingale (16). The former found a greater proportion of free amino nitrogen to protein nitrogen in stalks of potassium-starved sugar cane than in plants produced on full nutrients. Similar relations were found by Nightingale in responses of the tomato plant.

Early in the present work, we encountered samples of tubers produced from the same parent stock on peat soil, with the application of equivalent amounts of 0-20-0 and 0-20-20 fertilizers. The crop which received potassium remained white throughout the tuber after cooking, whereas the others were bluish throughout the tissue and black at the stem ends. From these results we proceeded to a study of potato color in relation to the soil supply of potash.

Plots of 0.125 (1/80) acre were laid out on silt loam at Madison, sandy loam at Arnott and silt loam at Antigo. At the time of planting, the available potash of the soils as measured by the Truog Method (17) were respectively 300 to 400, 200 to 250 and 150 to 200 pounds to the acre. Application of a 2.5-10-18 fertilizer was made at the rate of 600, 400 and 740 lbs. to the acre at the respective stations, with placement in the furrow. The responses obtained are presented in table 1. These show a general relation of discoloration to potassium deficiency, irrespective of the variety of potato. Similar results were obtained in a greenhouse on a synthetic sandy soil containing

TABLE 1—*Comparison of available potassium content of the soil with discoloration of boiled potatoes in the 1935 crop*

Location and Available K_2O Content of Soil	Fertilizer Elements Applied	Plot Number	Variety of Potato				
			Burbank	Cobbler	Katahdin	Rural New Yorker	
						Normal Seed Stock	Discoloring Seed Stock
Antigo 150-200	N-P-K	1	x	o	x	o	o
	N-P	2	o	x	o	x	x
		1	x	x	x	x	x
	none	2	x	x	o	x	x
		1	x	o	x	x	x
Arnott 200-250	N-P-K	1	x	o	o	x	o
	N-P	2	o	o	o	o	o
		1	x	o	o	o	x
	none	2	x	o	o	o	x
		1	o	o	o	o	o
Madison 300-400	N-P-K	1	x	o	o	o	o
	N-P	2	o	o	o	o	o
		1	x	o	o	o	x
		2	o	o	o	o	x

o=white after boiling. x=gray to black.

125 lbs. available K_2O to each acre. Application of 1200 lbs. of 4-10-20 fertilizer produced Cobbler and Russet Burbank tubers, in yields approaching 150 bu. to the acre, free from blackening after cooking. An equivalent application of potash-free fertilizer produced under 100 bu. to the acre of potatoes which discolored, and more decisively so with the Burbank variety. The water supply here was less influential than the potash supply. On the other hand, tubers from heavy yields of different varieties, containing low proportions of potash as produced on pure sand supplemented by several rarer mineral elements, in addition to a "complete fertilizer" salt formula, remained white after cooking. The several issues here involved are being subjected to further examination.

The preceding results suggest a regulatory role of potassium in discoloration. This role should be effective within the plant and may be localized in the tuber. This issue has been tested. Selections were made of tuber samples from potatoes found to be either normal or blackened after boiling. A more rigid selection could be made by indexing for the relative discoloration after boiling, and this might be expected to give less variable potassium content in the samples of each type of tuber. Potassium was determined on the tuber ash by the volumetric cobalti-nitrite method as developed by Truog and associates (15). Results obtained with the 1934 crop after paring are shown in figure 3. Closely similar results were obtained with the

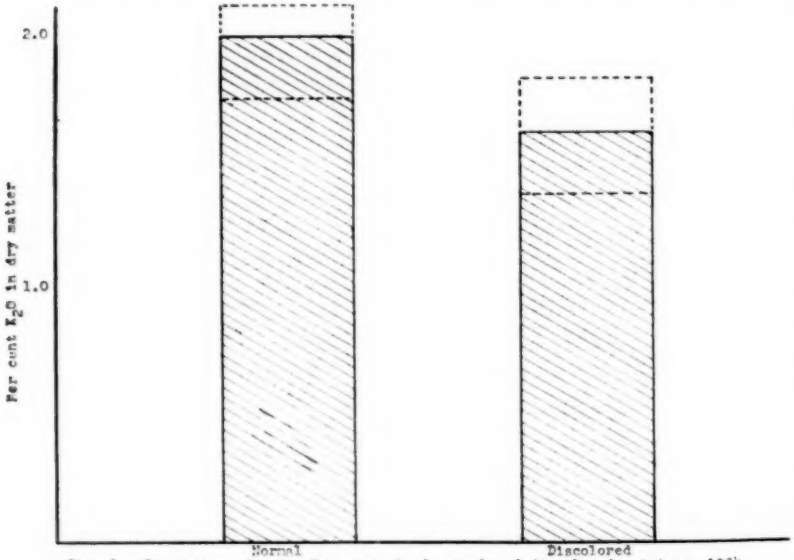

Fig. 3. Comparison of potassium content of normal and discolored potatoes, 1934. Showing also the range of contents.

unpared crop of 1935. As a general deduction, it appears that at levels below 1.8 per cent K_2O in the dry matter there is large probability of blackening after cooking. On the other hand, proportions of potash above this level are generally preventive of the abnormality.

The relation of tyrosinase to blackening of cooked potatoes.

Reference has already been made to the supposition of Merkenschlager (3) that tyrosine is converted in the raw tuber into autoxidizable precursors of melanin. In section 3, evidence was presented for the accumulation of unusual proportions of free tyrosine in tubers found to be subject to blackening after cooking. Obviously, a marked increase of liability to this form of discoloration would attend an increase in the proportion or activity of tyrosinase, the enzyme system responsible for at least the preliminary phases of oxidation of tyrosine to melanin.

For investigating the activity of this factor tubers were frozen by the use of solid carbon dioxide and the sap separated from the thawing tissue by pressure. Under uniform relations, an appropriate

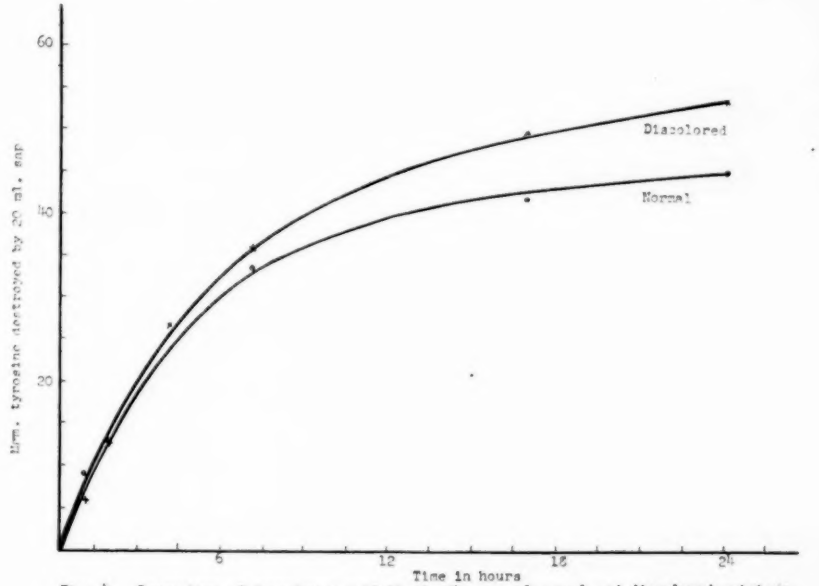

Fig. 4. Comparison of tyrosinase activity in the sap of normal and discolored potatoes.

proportion of isolated tyrosine was added to portions of the sap and the alkalinity adjusted to the favorable pH of 8.0 by use of a borate buffer. The several samples were preserved by toluene and aerated

while incubated at 25° C. Analysis of samples taken from time to time disclosed the rate of decline of the inclusive colorimetric reaction for tyrosine (13). Incidentally, it was found that the sap of five samples of discoloring potatoes contained, on the average, 30 per cent more tyrosine equivalent by this same index than did normal sap. Thirty samples gave the average results expressed in figure 4. In 24 hours, the average conversion of tyrosine was 20 per cent greater by action of sap from abnormal than by that from normal tubers. This effect might be caused by differences of either amount or activity of the enzymic system. Preliminary evidence has indicated that the rate of action of this system is modified by the direct addition of inorganic salts, and this aspect of the problem is receiving further attention.

Summary.

1. The blackening of cooked potatoes does not appear to be associated with transmissible, pathological conditions.

2. This abnormality appears to be associated to a limited extent with higher percentages of nitrogen in the dry matter of the tuber.

3. In comparison with normal potatoes, those which blacken after cooking contain in the raw state, relatively high proportions of free amino acids. This relation applies particularly to tyrosine, which fails to show the normal increase on boiling the abnormal tubers.

4. Immaturity of the plant is not a primary factor in the blackening of tubers after cooking.

5. Storage at high temperature and with greatly curtailed ventilation does not induce the blackening response significantly.

6. Enzyme hydrolysis of protein in incubated potato tissue is more extensive in tubers which blacken than in those which remain white after cooking. Protein isolated from such abnormal potatoes is also relatively instable, as indicated by the response to mild hydrolytic treatment.

7. When the soil content of available K_2O was less than 200 lbs. to the acre, potatoes of several varieties blackened after cooking, but this response was negligible when the supply approached 400 lbs. Samples containing large proportions of blackening tubers contained an average of less than 1.8 per cent K_2O in the dry matter, whereas the average content was above this level in normal tubers.

8. Sap from potatoes which blacken after cooking, is considerably more active in the oxidation of tyrosine than that from normal potatoes.

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THE RELATION OF PLOT SIZE AND SHAPE TO POTATO YIELD VARIATIONS[1]

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The efficiency of plots of different sizes and shapes is known to have an important relationship to the cost of conducting yield tests. The two-rod single row plot has been extensively used for tests of this nature, and it is of interest to compare this type of plot with others when the analysis of variance method is used for making the determination.

A study which should serve as a general indication as to what variation of yields may be expected from different plot sizes has been made. The yield figures to be used were collected from a planting of 42 rows, three feet apart, eighteen rods in length. The planting was harvested in one-rod sections. It is therefore possible to combine these and have the yields of plots of various lengths and widths. The data were worked up by the analysis of variance method as described by Fisher. It was assumed that the planting consisted of a comparative yield test of seven varieties, and that these were located according to Fisher's randomized block method. It is necessary that each block contain a replication of each variety and that the varieties be distributed within each of the blocks entirely at random. This method is adapted to trials that contain a large number of treatments or varieties to be compared. The total error is divided into components and that part of it which is due to

Table 1—Effect of plot lengths and widths on S. D. of a single plot in per cent of the mean of all plots.

Length of Plots in Rods	Width of Plots in Rows			
	1	2	3	6
1	18.71	15.94	15.18	11.98
2	14.48	14.81	14.09	11.25
3	14.10	13.85	13.21	10.28
6	11.78	12.14	11.83	9.13
9	11.47	12.18	11.63	8.37
18	8.67	10.04	9.95	7.18

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variation between blocks is eliminated. The worker may then compare the variation due to treatment with that caused by other conditions within the blocks. Immer (1) gives details as to the use of the method for a study such as the present one.

Table 1 shows the standard deviations expressed in per cent of the mean. This has been called coefficient of variability. It is of some interest to note the slight effect that increasing plot width has in reducing the variability. This probably results from the tendency of most soils to vary in productivity in circular areas. The wider plots would tend to coincide with these, whereas the longer plots cut across them. The one-row plots are perhaps most satisfactory for general use, and under the conditions of this test they are seen to decrease gradually in variability as the length is increased. But the reduction is not marked beyond the two-rod length until the 18-rod length is attained. It appears, therefore, that the two-rod single-row plot was suitable for a randomized block yield test under these conditions, although the standard error of a single determination is considerably higher than ten per cent of the mean, which is usually thought to indicate suitable accuracy.

It is of some interest to compare the data from the various plot sizes relative to the number of replications. Table 2 is a summary of the data on this. The calculation is based on the assumption that the difference to be measured is one of approximately ten per cent or greater, with odds of 20 to 1 considered satisfactory. It may be that a difference smaller than ten per cent would be worthy of consideration for an intensively grown crop such as potatoes. However, it is probably true that average facilities are not adequate for conducting a yield test for extreme accuracy. The number of replications was calculated by finding the number needed to give a standard

Table 2—Approximate number of replications needed to measure a 10 per cent difference and obtain odds of 20 to 1.

Length of Plots in Rods	Width of Plots in Rows			
	1	2	3	6
1	20	21	19	12
2	17	18	16	10
3	16	16	14	9
6	11	12	11	7
9	11	12	11	6
18	6	8	8	4

error of the mean of 3.5 per cent. This is approximately the figure needed to give a standard error of a difference between two means of 5 per cent.

The data of the table are obviously of the same nature as those in table 1, since the smaller plots require more replications. The point of greatest value is perhaps the relation of area that would be required to achieve a given result with the different plots. In this connection, it should be emphasized that smaller plots are always more efficient over a given area because replication is more effective in decreasing variation than is increasing the plot size. This, of course, refers to the variation of the means. The number of replicates to use must be varied according to conditions, such as area to be used for the test, size of plot, labor available, difference to be measured, etc. It does not seem that a general recommendation can be followed in this respect.

Relative to the inter-relationship of plot size, difference to be measured, and area to be utilized, table 3 may be helpful. These figures are taken from table 2, by finding the area that would be required for each variety. The areas are expressed in fractions of an acre and represent only the requirements of an individual variety. The total area, of course, would be the figure as given in the table, mutiplied by the number of treatments.

Table 3—Area, in acres required by each variety or treatment if a difference of 10 per cent is to be measured with odds of 20 to 1.

Length of Plots in Rods	Width of Plots in Rows			
	1	2	3	6
1	.0329	.0477	.0648	.0818
2	.0387	.0818	.1091	.1364
3	.0545	.0966	.1452	.2045
6	.0818	.1773	.2454	.3273
9	.1227	.2659	.3682	.4295
18	.1432	.3682	.5523	.6136

The smaller plots show a decided advantage in this respect with the one and two rod single-row plots not being decidedly different. The testing of any number of varieties with the large plots would involve the use of several acres.

The customary practice of workers is to adjust the size of plot to what they can care for under their particular conditions. In

many cases, limited space is available, but adequate labor and well-trained assistance may be had, so that small plots with numerous replications would be used. At other stations, where large areas, but limited help are available, it would be desirable to give more consideration to plots of larger size, and by so doing, reduce the replicates and the manipulations required in planting and harvesting.

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CONTINUOUS CULTURE VERSUS ROTATION FOR POTATOES

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Rotation of crops as a means of increasing yields has been practiced for centuries. The earlier agriculturists did not know the reasons why growing different crops on a piece of land usually resulted in improved growth. Even today with the aid of many scientific discoveries and generations of experience, it is frequently impossible to credit correctly all the factors involved in growing a good or poor crop. This is particularly true of conditions in the soil.

In recent years many potato growers in northeastern United States have been planting their land with potatoes nearly every season. Some claim that the yields continued to increase under this system. This may have been true for a few seasons if the weather happened to be a little more favorable in successive years. It is also possible that if a grower started with run-out land, the increases in production from year to year resulted from the building up of the depleted reserves of phosphorus and potassium in the soil by liberal fertilzation. Whatever explanation may be given for increases of this kind, some results obtained at the Storrs Agricultural Experiment Station indicate that continuous cropping with potatoes has its disadvantages.

The first marked example of the beneficial effects of turf land on potatoes was brought to the writer's attention approximately fifteen years ago. Two annually tilled fields and a blue grass roadway, which had separated them for ten years, were planted to potatoes, all receiv-

ing the same fertilizer and other treatments. The season was too dry for potatoes. However, it soon became evident that the potatoes on the former blue grass roadway were making much more vine growth than on the formerly tilled fields. The yields were not determined, but it was estimated that at least twice as many marketable tubers per unit area were obtained from the roadway.

We have considerable data in the second comparison. In 1929, a field which had been in hay and pasture for twenty or more years was planted with potatoes. Since then potatoes have been grown on one-third of the field every year, whereas on the other two-thirds, potatoes have been alternated with a crop of clover and timothy, usually cut for hay. On each section, ten different fertilizer treatments have been added to duplicate plots of potatoes. In these trials, a fertilizer treatment low in any one of the three elements—nitrogen, phosphorus or potassium—produced smaller crops, especially on the section of the field planted continuously to potatoes. We need not be much concerned about results where insufficient plant nutrients are applied, for practically all commercial growers now use ample amounts of well-balanced fertilizers. However we should take notice when under continuous culture, even with liberal fertilization, yields are much poorer in some seasons. To illustrate this point, the average production of four fertilizer treatments each carrying sufficient amounts of nitrogen, phosphorus and potassium for maximum production, is given below for the five-year period, 1931 to 1935. For facilitating a comparison of the "continuous potatoes" and the "potato-clover and timothy" series, relative yields are used, with the production of the "continuous potatoes" plots taken as 100.

Cropping System	1931	1932	1933	1934	1935	Average
Continuous potatoes since 1929	100	100	100	100	100	100
Potatoes alternating with clover and timothy	89	117	103	103	132	109

In three of the five years, the plots planted every year with potatoes yielded about as well if not better than the rotated plots. But in 1932 and 1935, rotation was evidently responsible for increases in marketable tubers of seventeen and thirty-two per cent

respectively. In those years, the yields of all plots were less than in the seasons of 1931, 1933 and 1934. Dry weather seems to have been the chief reason. In 1932, the rainfall for April, May, June and July was among the lowest on record for those four months since 1888. In 1935, all months of the growing season with the exception of June, had experienced subnormal precipitations. Although soil samples were not taken from the two areas for moisture determinations, results indicate that the potatoes on the continuously tilled series suffered more than the rotated ones from a deficiency of moisture.

The yield differences of seventeen and thirty-two per cent in favor of rotation are large enough to justify some attention from growers. Moreover, in seasons when weather conditions are unfavorable, the unit price of a crop is usually much higher than in years with favorable weather; witness the differences in the prices of potatoes in 1934 and 1935. Therefore, a system which includes a sod-forming crop should tend to reduce wide fluctuations in potato yields and also the incomes of growers.

The results cited above occurred on a level loam soil, high in organic matter. There is ample evidence in the literature to show that on sloping land or on soils with less organic matter, rotation would be much more important, not only in increasing current yields during poor seasons, but by reducing the washing away of the valuable top soil during periods of heavy rainfall.

In making plans for growing other crops on potato land, a few points seem worthy of emphasis. (1) The land should be tilled as little as possible, for such operations decrease the organic matter and increase the losses from leaching and erosion. For example, rye may be seeded after potatoes are harvested in the fall and clover and timothy seeded early the following spring, all without any plowing or harrowing. The rye may be mowed when headed and the clover and timothy once during the summer, using both crops for hay if needed; if not, they may be allowed to rot on the ground. Therefore no stirring of the soil need occur for at least one entire season. (2) Turf forming, biennial or perennial crops, such as the clovers and grasses are superior to annuals like soybeans, rye, oats, etc. (3) If no legumes are present in such seedings, the growth of the grasses may be stimulated with nitrogenous fertilizers. (4) Most of the better legumes and grasses do not thrive on very acid soils (pH 5.0 or below) and 600 to 1000 pounds of limestone to the acre will usually be of great benefit. (5) To reduce erosion, perform all tillage operations at right angles to the direction of the slope.

CURLY DWARF IN COLORADO

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This disease was first observed in the Brown Beauty variety in the San Luis Valley in 1933 when only an occasional plant was observed. After a severe drought and psyllid infestation in 1934, however, the disease was prevalent enough in 1935 to cause the rejection of eighty per cent of the Brown Beauty acreage entered for certification. Observations, during the 1935 season, demonstrated that the lower leaves of plants on either side of infected plants in the row showed symptoms. Plants opposite infected plants in adjacent rows also showed the characteristic curling of the lower leaves indicating that possibly the disease was caused by a virus and was transmitted by insects. Core-graft tests are now being conducted to verify these observations.

Plants showing symptoms of curly dwarf are dwarf-like in character, seldom attaining a height of more than twelve inches. The leaflets curl downward from the tip toward the petiole and may also fold upward with the midrib as a center. The leaves are sometimes lighter green than normal. No mottling is present, but a mild crinking or puckering between the veins accompanies the other symptoms. In the greenhouse, the lower leaves turn yellow; a distinct necrosis, spotted in character, shows in the veins only on the lower side of the leaflet, and the leaf eventually dies and drops. Brown streaks appear on the stem contiguous with the dead leaf petiole. Many of these symptoms are identical with those of streak. But no mention of the extreme dwarfing or the curling of the leaflets has been made in connection with streak. All other symptoms of this disease are identical with those described by Orton (1) for curly dwarf. The streak symptoms on the vine were observed only under greenhouse conditions and not in the field. The plants are somewhat brittle. The symptoms mentioned have been observed only in the Brown Beauty variety.

Many of the tubers gathered from curly dwarf hills show triangularly-shaped lesions with the epidermis curling away from the shallow cavities thus created. After a period in storage a shallow, sunken black area appears surrounding the lesion, on the skin. This

sunken black area is hard and leathery in texture and does not extend into the tuber more than one-eighth an inch. Cultures of this tissue have, so far, produced nothing except saprophytic organisms. In a few extreme cases the entire flesh of the tuber has become a brownish-yellow color after the storage period. In some instances the death of all eyes on the tuber has resulted. The tubers were dug from the infected hills in August and held at room temperature until December at which time the above symptoms were observed.

Similar tuber lesions have been observed in connection with streak by Atanasoff as reported by Murphy, P. A., and McKay, R. (2). These authors also report the presence of tuber lesions on the variety President in cases where symptoms of the streak disease were present in the vines.

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SECTIONAL NOTES

CALIFORNIA

There were considerably fewer potatoes left in the Stockton District on November 1st this year than there have been for many years in the past. For the next six months, California will get nearly all its potatoes from outside states and most of these will come from the Klamath District of Oregon. The quality of potatoes grown in Klamath was so superior to the quality grown in Idaho that California will draw almost entirely from Klamath.

Because of the increased outlet of Klamath potatoes into California this year, the Klamath growers will have no problem. All the potatoes grown in Klamath can be marketed in California and Oregon without, at any time, overloading the markets. In addition to all the potatoes that California will buy from Klamath, they will also use a reasonable supply from Idaho, although this quantity will not be so great as it has been in the past.

The three Pacific Coast states of Washington, Oregon and California have no potato problem this year and will, in no degree, compete in the general competitive markets with any of the other potato

states. This condition will simplify the marketing problems of Idaho for the reason that the Netted Gem demand for the United States will be confined almost exclusively to themselves. (Nov. 9).—H. G. ZUCKERMAN.

COLORADO

Since harvesting has been completed in all parts of the state, the yield shows that Colorado has a considerably larger crop than was estimated October 10th. In the San Luis Valley, which is the largest shipping section in the state, and which section produces over one-half of the state's crop, the crop is the largest recorded in history.

Stock that is being shipped from this district, at the present time, is being taken mainly from temporary storage. It is estimated that there are between 7,000 and 8,000 cars in storage at present and more than 4,500 have already been shipped. Last year the total movement from the San Luis Valley was 9,000 cars. This also included the truck movement. It appears that the rail movement this year will exceed the total movement last year by approximately 2,000 cars.

Some difficulty is being experienced because of field frost, as practically the entire state experienced, about October 6, a period of low temperatures, and potatoes which were not well covered were frosted at this time.

The Colorado Pure Seed Show will be held at Colorado Springs, during the week of November 16. The State Potato Show will be held in connection with this Pure Seed Show. Approximately two to three hundred entries are expected. These consist mostly of the winners at the county shows which were held during the fall. The annual meeting of the State Certified Seed Growers' Association will also be held in connection with the show. (Nov. 10).—C. H. METZGER.

IDAHO

Idaho's potato crop is practically stored at this time, or at least all the potatoes are harvested. A heavy frost during the latter part of September attacked the partially undeveloped crop of the Snake River Valley. Although we do not know what the yield of the state will be this season, it will necessarily be considerably less than if the crops had had a longer growing period. The difference is probably between two and four million bushels.

The crop has been marketed at a more rapid rate this year than last, so that today's report shows that over 9,000 cars have been sold, compared with approximately 6,000 last year. As was suspected

earlier in the season, there is a rather high percentage of No. 2 stock, which is the result of non-uniform growing conditions.

Although the acreage was practically the same, the certifiable seed potato crop is much greater in tonnage than it has been for the past two or three years. At the present time we have not determined the total yield of the seed potato crop, but in the more important growing districts, as Fremont and Teton counties, the yields, owing to unusual precipitation during the growing season, will average approximately 100 sacks to each acre. Of this amount, a smaller percentage will meet the qualifications for certification, as much of the stock weighs more than twelve ounces.

Practically all of this stock has been harvested without severe freezing, so that there should be little loss in storage, and the quality will, on the average, be much better than in previous years.

Regarding varieties, the percentage of early potatoes, particularly Bliss, is much greater than in previous years. This variety shows less disease this year than at any time during the history of certification in Idaho.

The Pacific Northwest Potato Growers' Association held its annual conference at Spokane, October 26 and 27. These meetings were attended by representatives from Oregon, Washington, Idaho, and Montana. The program covered subjects of interest to potato growers, particularly regarding a study of the factors determining high quality and satisfactory yields. (Oct. 30).—E. R. BENNETT.

INDIANA

The continued heavy and exceptionally late rain, with a late killing frost, delayed our harvesting operations considerably in Indiana and it looks as though a lot of our potatoes or those that we have left will be harvested with a lot of mud attached to them. This means that we should face a large task in getting them cleaned up for local consumption or for those who have some commercial trade. It will be rather difficult to estimate what our yield will be this year. Although the late fall did increase the yield to some extent, still it looks as if we would not exceed four and a quarter million bushels. This still leaves our yield considerably short and I presume there will be a market in Indiana for table and seed stock of approximately eight million bushels for some one.

Our best yield in the state this past season was produced upon muck soil in northern Indiana, on which there were 493 bushels of

No. 1 potatoes produced to the acre. This season additional growers were declared winners in our 400 Bushel Potato Club.

Incidentally, the Katahdin variety produced the best yield this year, and our growers are beginning to like this variety better and better all the time. From observations made in our demonstrational plots by some of our better growers, the Katahdin appears to be the most promising variety to grow in central and southern Indiana, especially where there is danger of damage from leafhoppers and also from the hot and dry weather. The foliage is apparently so resistant to these factors that there is little damage noticed upon these plants and the yields are far superior to those of any other variety we have tested to date. Katahdins were planted in central Indiana as late as July 26, and they matured a crop of potatoes this year, before our first killing frost on October 25. We experienced exceptionally hot and dry weather during July and August and the first part of September. (Nov. 11).—W. B. Ward.

MINNESOTA

The estimated production of potatoes in Minnesota, as of November 1, is 12,600,000 bushels, 540,000 bushels more than estimated in the October report. This is less than half the annual production during normal years. The quality varies according to locality. To date, relatively few shipments have been made.

A summary of the seed potato certification work for 1936 follows:

Variety	Acreage Inspected	Acreage Rejected or Withdrawn	Acreage Passed	Bushels Certified
Bliss Triumph	1906.5	57.0	1849.50	175,700
Irish Cobbler	5425.77	688.25	4737.52	359,575
Early Ohio	623.34	65.5	557.84	49,045
White Gold	24.0	1.0	23.0	4,015
Warba	401.99	5.75	396.24	35,650
Chippewa	73.4	7.45	65.95	6,335
Green Mountain	116.86	52.0	64.86	7,345
Russet Burbank	24.8	15.0	9.8	1,370
White Rose	389.75	42.5	347.25	34,000
Rural New Yorker	8.0	0.0	8.0	640
Russet Rural	1.5	.5	1.0	100
Katahdin	23.62	4.0	19.62	1,470
Golden	.1	0.0	.1	10
	9019.63	938.95	8080.68	666,855

Although we have passed a larger acreage for certificaton this year than in 1935, the total production is just about one-half the previous year's crop. The summer drought, continuing into August, had a marked effect on the yield, although in some sections of the state, the rainy period which prevailed late in August had a most beneficial effect on many fields. The certified seed potato growers on the peat soils probably averaged better yields than last year and the quality of the stock produced was very good. Seed-consuming centers evidently realize that there is a shortage of good seed stock, and the seed business is unusually active for this time of the year. (Nov. 13).—A. G. TOLAAS.

MARYLAND

The statistics on potato certification work in Maryland for 1936 are given in the table below.

SUMMARY OF WHITE POTATO SEED CERTIFICATION WORK IN MARYLAND VARIETIES
1936

Variety	Total Inspection Acres	Eligible for Certification		Disqualified Acres	Discontinued Acres
		Acres	Bushels		
Irish Cobbler	556.125	421.5	38,115.0	79.75	54.875
Smooth Rural	110.50	52.25	13,062.5	0.5	57.75
Dakota Red	44.25	34.75	6,950.0		9.50
Russet Rural	13.125	13.125	3,281.25		4.5
Katahdin	11.25	6.75	1,237.5		
Chippewa	6.25	6.25	937.5		
Bliss Triumph	3.25	3.25	307.5		
McCormick	2.875	1.375	275.0		1.5
Green Mountain	1.50	0.50	88.5		1
Warba	0.50	0.50	75.25		
Up to Date	0.375	0.375	62.5		
Totals	750.000	540.625	64,392.5	80.25	129.125

R. A. JEHLE.

MASSACHUSETTS

The marketing of the 1936 crop is proceeding normally with wholesale prices ranging from $1.80 to $1.90 for one hundred pounds. Both the yield and the quality have been good. Of the yield records secured from thirty-one growers enrolled in the 300 Bushel Club, the three highest yields ran 630, 597, 593 respectively, with yields of the entire acre having been weighed in the case of two of the leading growers. (Nov. 13.)—RALPH W. DONALDSON.

NEW YORK

The potato crop estimate for New York as of November 1 is 27,000,000 bushels, an increase of more than a million since October and nearly as large as 1935. The writer expected a change in the opposite direction because of so many disappointments at harvest time. At this date, November 12, the last of the 1936 acreage is being harvested. Two periods with extremely low temperatures occurred early in November which resulted in injuring some potatoes which were not yet harvested. No blight rot has been reported in the New York crop. The abnormal weather also resulted in a larger percentage of misshaped tubers than normal and because so much of the crop was immature when dug, the proportion of the total crop which will grade No. 1 will be reduced. Storage shrinkage will also be higher than normal.

Growers, in general, have a tendency to hold the crop for better prices. Farm prices now range from 80 cents a bushel at western New York country points to $1.10 a bushel on Long Island. The New York Cooperative Seed Potato Association will hold a meeting at Syracuse on November 14 to consider supply and price for certified seed. At the present time no pool prices have been established.

Because of the higher price level compared with last year, city markets are handling mostly local stock and Maine Green Mountains; few Idahoes are in evidence. Considerable blight rot is prevalent in the Maine stock and this may be responsible for the present slow market.

Our potato consumer preference study in Cleveland is progressing nicely. Our present supplies are being purchased almost entirely from Maine and Ohio. In addition, only a very few Russet Burbanks from

Idaho are being sold for baking stock in this market. (Nov. 12).—E. V. HARDENBURG.

PENNSYLVANIA

The moist weather during October was very favorable for the potato crop. Killing frosts did not appear until the cold period of October 27, when temperatures as low as 8° F. above were reported. A few scattered acres of potatoes still remained to be harvested at that time. The certified seed crop was practically harvested before the cold period arrived.

In the southeastern part of the state, especially in the Lehigh County section, yields were rather disappointing. Growers who usually averaged nearly 400 bushels to the acre harvested 250 bushel crops, many of which were somewhat rough and off-type.

In the mountain counties, yields ran very high. A number of certified seed growers averaged well above the 400-bushel mark. A few of the crops produced some rather large tubers with considerable second growth, whereas others were smooth and true to type.

Our certified seed crop will likely exceed 200,000 bushels, which will be the second highest we have ever produced. In 1934 we grew 241,000 bushels, which was the largest certified seed crop ever grown in this state. The seed crop this year will not be so smooth as last year's crop, but there will be less stem-end discoloration, scab and late blight infection that we have produced for several years.

This year, for the first time, we are sending seed to Florida. Five carloads of Bliss Triumph seed were shipped from Potter County during the past month.

Considerable seed was sold this fall at prices ranging up to $1.50 for each bushel.

The marketing program of the Pennsylvania Potato Growers' Association is being met with approval in a manner which is astounding to the few skeptics who thought the plan would not work. Under this program the Association adopted a grading standard with a 2 inch minimum for the "Blue Label" stock. This "Blue Label" is the trade-mark of the Association and every bag of potatoes sold under this plan bears the trade-mark of the Association and the growers' stamp. Nearly all potatoes shipped to date were in 15-pound paper sacks, although some were sold in 60-pound bags.

Nearly 300,000 bushels of potatoes were sold under this plan this fall. There are fifteen grading centers scattered throughout the state.

through which most of the potatoes passed. A few large growers who market under the "Blue Label" grade their own stock. (Nov. 13).—K. W. LAUER.

VERMONT

By a recent ruling of the State Department of Agriculture, blue tags are to supplant the uncolored ones previously used on Vermont certified seed. It is pointed out, however, that since a considerable number of the old style tags were on hand at the beginning of the season, some lots of this year's crop will be labelled with them. The new tag carries the state coat of arms in red and the same printed statements that appeared on these in former use.

At the annual meeting of the Directors of the Vermont Certified Seed Potato Growers' Association, October 13th, a resolution was passed disapproving of the use of the grade term U. S. No. 1 with small size specifications, such as "1¼ to 2 inch diameter".

Approximately ten carloads of seed have been reported sold to date. Prices varied from $1.20 to the bushel, untagged, to nearly $1.45 for each bushel regular grade, F. O. B. grower's station.

Practically no late blight was reported after the second inspection of fields entered for certification. Observations, particularly in the northeastern part of the state, show the presence of 20 to 50 per cent late blight infection on tubers which are being harvested in small uncertified fields. (Nov. 5).—H. L. BAILEY.

VIRGINIA

We have but little definite information in connection with plans for 1935, but what we have, would indicate increased planting in South Carolina and farther south. What this increase might be is not available, but one would expect an urge to increase the acreage, in view of the splendid prices received by the growers in those sections.

I have not talked with any of the authorities or growers in North Carolina, but the prices of last season will surely lead to some acreage expansion.

The Eastern Shore farmers still talk of the danger of increasing plantings to any extent. Perhaps this fear of a recurrence of the disasters of several years prior to 1936, may deter any considerable increase in acreage. We would hope so, but we can not tell until later in the year what the final conclusion of our farmers will be.—G. S. RALSTON.

CANADA

A total of 19,552 acres of potatoes was entered for inspection with a view to certification in 1936 and 16,440 acres passed field inspections. The acreage passed is about 311 acres less than that which passed for seed in 1935. The slight average increase in yield to the acre in 1936 had been offset by losses caused by late blight rot in Eastern Canada, amounting to nearly two per cent of the crop, and the total quantity of certified seed in 1936, is, therefore, somewhat less than in 1935.

Certified seed potatoes have been moving out rapidly since harvest and the prospects for future sales are exceptionally good. The movement started in Nova Scotia as early as the third week in August and has continued more or less steadily since.

In Nova Scotia, all Bliss Triumph, Katahdin and Garnet Chili certified seed available for export, has already been sold, and practically all the Irish Cobblers will have been shipped by mid-November. With promises of increased orders for some varieties, operators are planning for an increased acreage for next season.

In New Brunswick, the demand for certified seed has been very good this fall and approximately 360,000 bushels were shipped before October 31st. The prices received are higher than for several years, and the outlook promises a most satisfactory season.

On Prince Edward Island, the crop was harvested somewhat later than in other districts and only a few shipments were made before November, but there is an excellent demand for certified seed this year at very fair prices, and a good season is anticipated.

In other parts of the Dominion, the local supplies of certified seed are apparently short of their requirements. Quebec will probably require some Green Mountains, and Ontario is short of certified Irish Cobblers. The seasonal conditions in the Prairie Provinces have resulted in a short crop and some seed will be required from outside sources. The British Columbia crop will be disposed of locally at satisfactory prices.

Export shipments for the fall months have about doubled those of a year ago for the same period, and prospects indicate that seed will be scarce by spring, and will be higher in price. A small increase in seed potato acreage is expected in 1937. (Nov. 6).—JOHN TUCKER.

WANTED

Back numbers of the Potato News Bulletin and the American Potato Journal. We are particularly interested in the following issues:

All numbers of Potato News Bulletin, Vols. 1 and 2.

All numbers of American Potato Journal, Vols. 3 and 4.

American Potato Journal, Vol. 5, Nos. 3, 5, 6 and 7.

American Potato Journal, Vol. 6, Nos. 5 and 11.

American Potato Journal, Vol. 7, Nos. 4 and 6.

American Potato Journal, Vol. 8, Nos. 5, 6 and 7.

American Potato Journal, Vol. 9, No. 6.

American Potato Journal, Vol. 10, Nos. 4 and 8.

American Potato Journal, Vol. 12, No. 2.

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FERTILIZER FOR THE POTATO CROP

In many potato growing sections the fertilizer bill is one of the chief items contributing to the cost of the production of the crop. It is, therefore, important that the growers have the benefit of all available information on this question. Progress has been made in our knowledge of potato fertilizers and their use. A reading of the excellent resume of the changes in potato fertilizer use by B. E. Brown, in this issue of the Journal demonstrates this fact.

The expenditure of large sums annually for fertilizer is justified but it is quite possible that certain modifications may be made which will result in increased returns to the grower. For example, we need to know more concerning the role of the minor elements in the nutrition of the potato plant. Additional information concerning the relative merits of acid and neutral mixtures should be made available. Scab is an important factor in many potato growing sections. In some cases the disease has largely been controlled by adjusting the soil pH values to approximately 5.0. In these cases the grower is concerned as to whether he should continue to use an acid mixture or change to one having an alkaline reaction. He appreciates that the use of an alkaline mixture may be followed by increased pH values locally and this in turn by an increase in scab. He is, therefore, confronted with the possibility of low yields on one hand and scabby potatoes on the other. More attention needs to be given also to the role of super phosphate in potato production on our acid soils. These are only a few points to be considered. The time has come when we should devote less time to the mere testing of materials and amounts of fertilizer and direct our attention to a study of the basic principles underlying the nutrition of the potato crop. Careful investigations, with this as their aim, should have the support of all interested in the industry.